

## Scaffolding under the microscope: applying selfregulation and other-regulation perspectives to a scaffolded task

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## **Scaffolding under the microscope: applying self-regulation and other-regulation perspectives to a scaffolded task**

### **Abstract**

**Background** Typical scaffolding coding schemes provide overall scores to compare across a sample. As such, insights into the scaffolding process can be obscured: the child's contribution to the learning; the particular skills being taught and learned; and the overall changes in amount of scaffolding over the course of the task.

**Aims** This paper applies a transition of regulation framework to scaffolding coding, using a self-regulation and other-regulation coding scheme, to explore how rich and detailed data on mother-child dyadic interactions fit alongside collapsed sample-level scores.

**Sample** Data of seventy-eight mother-child dyads (M age = 9 years 10 months) from the Sisters and Brothers Study (SIBS: Pike et al., 2006) were used for this analysis.

**Methods** Videos of the mother and child completing a block design puzzle task, involving multiple trials, at home were coded for their different self- and other-regulation skills at the end of every block design trial.

**Results** These constructs were examined at a sample level, providing general findings about typical patterns of self-regulation and other-regulation. Seven exemplar families at different ends of the spectrum were then extracted for fine-grained examination, showing substantial trial- and behaviour-related differences between seemingly similarly scoring families.

**Conclusion** This coding scheme demonstrated the value of exploring perspectives of a mother-child tutoring task aligned to the concept of other-regulation, and investigating features of the interaction that go undetected in existing scaffolding coding schemes.

## Introduction

The metaphor of ‘scaffolding’ (Wood, Bruner & Ross, 1976), now entering its fifth decade, is used throughout developmental and cognitive psychology, applied to various topics (Granott, 2005), and operationalised in diverse ways for research purposes. Global maternal ‘scaffolding quality’ scores, compared across dyads, have shown their value in the wealth of existing research. However, these varied operationalisations of scaffolding introduce some challenges to the research area. Some measures show a drift from the fundamental principles of the *theory* of scaffolding. Furthermore, reducing down detailed behavioural observations for overall ‘scores’ may obscure interesting and important between-family differences.

While reconfiguring the original scaffolding metaphor for empirical studies is a welcome scientific endeavour (Granott, 2005), there is value in looking back to the original ideas from which it emerged (e.g., Gauvain, 2005; Lajoie, 2005). This paper aims to return to the early principles, and bridge the detailed, process-oriented, dynamic analyses from the early scaffolding literature and the more quantitative, outcome-focused assessments of scaffolding quality more commonly used today. We describe an adapted coding scheme that tracks the three principles of scaffolding (*transfer of responsibility*, *contingency* and *fading*) which are not all always built into existing scaffolding coding schemes. Drawing on fine-grained coding practices, we investigated the tutoring and learning process during a videotaped task (see Carr & Pike, 2012), and aimed to apply an adapted coding scheme that describes specific characteristics of individual mother-child dyads, to examine what gets lost when collapsing these data for global scores to compare across families.

We shall first provide some overall context in which to position this work, by outlining the conceptual features of scaffolding and detailing how they may or may not fit with existing coding schemes.

### *Transfer of responsibility*

While the feature *transfer of responsibility* is often referred to, it does not describe what is actually taking place for the child to take on more responsibility of the task. One insight into how enables this shift in ownership comes about was by Wertsch (1979), a contemporary of Wood's, whose work neatly dovetails his own. Wertsch's observations of mother-child tutoring interactions mapped Vygotskian theories of socio-cognitive learning (Vygotsky, 1978) onto actual interactions. He described the social learning process as a 'transition of regulation', emphasising that in tutored sessions children develop the *self-regulation* skills required for the task; by extension, adults demonstrate and model these self-regulation skills for the child (*other-regulating*). Scaffolding can then be understood as the strategies the mother uses to aid the *transfer of regulation* to the child over the course of the task. This perspective has since been used to describe the tutoring process more generally (e.g., Díaz, Neal, & Amaya-Williams, 1990; Lajoie, 2005).

While maternal scaffolding could be conceptually understood as *other-regulating* behaviour, the actual measurement of scaffolding usually does not explicitly reflect other-regulation behaviours. Instead, *overall* support is often measured, either by the *amount* of support (e.g., Carr & Pike, 2012; Conner & Cross, 2003; Fernandes-Richards, 2006; Pratt, Kerig, Cowan, & Cowan, 1988; Wood, Wood, Ainsworth, & O'Malley, 1995) or the *appropriateness* of support (e.g., Englund, Luckner, Whaley, & Egeland, 2004; Hammond, Carpendale, Bibok & Liebermann-Finestone, 2012). Where support behaviours *are* coded separately, they tend to be classified by explicit actions (e.g. Wood, Bruner & Ross, 1976;

Lindberg, Hyde & Hirsch, 2008) or by whether the support is cognitive or emotional (Pianta & Harbers, 1996), rather than by the specific regulation behaviour being modelled for the child to internalise.

Given that Wertsch's notion of regulation transition is bolstered by statistical associations between maternal scaffolding quality and both the child's later self-regulation skills (e.g., Neitzel & Stright, 2003; Pino-Pasternak & Whitebread, 2010; Stright, Neitzel, Sears, & Hoke-Sinex, 2001), and indeed skill development within a task (Pino-Pasternak, Whitebread & Tolmie, 2010), it is surprising that *other-regulation* is rarely operationalised for tutoring research (two exceptions are Nader-Grosbois, Normandeau, Ricard-Cossette, & Quintal, 2008; and Hadwin, Wozney, & Pontin, 2005). The self-regulatory skills internalised by the child during a scaffolding interaction tend not to be examined (see Pino-Pasternak et al., 2010 for an exception), so few self- and other-regulation coding schemes exist.

In contrast, in the literature on technology, the other-regulating role of the device is clearly considered in coding schemes (see Lajoie, 2005). Once such scheme is used in this paper and applied to scaffolding, to observe the emerging self-regulation of the child, *along with* the corresponding other-regulation of the mother, to operationalise the original concept of the transfer of responsibility, and plot *how*, in addition to *whether*, optimal scaffolding took place.

### *Contingency*

Another key concept of scaffolding is that the mother's support is contingent on the child's own behaviour and actions, or when the child signals support is needed. While the tutor's behaviour and skills are crucial to the process and product of an interaction, the contribution of the child is also a determining factor: the child's own effort "*assists the adult to assist*" (Tharp & Gallimore, 1998, p. 101, original italics). Vygotsky (1978) described

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learning as an *internalisation* by children of behaviours externally modelled by the ‘expert’, which requires effort on behalf of the child; they are active participants in their own learning experience. A mother can scaffold in a highly contingent way, but unless the child is also able to clearly signal need for assistance and willing to internalise the lessons, it will not be successful. In scaffolding measures, however, the child’s input is rarely directly examined as a discrete element of the learning experience; instead, the child’s behaviour (either prior to or directly after an intervention by the tutor) is typically used as a device for judging the adequacy of the tutor’s scaffolding and contingent levels of support (e.g., Carr & Pike, 2012; Conner & Cross, 2003; Pino-Pasternak, Whitebread & Tolmie, 2010; Pratt, Kerig, Cowan & Cowan, 1988). The child’s success at the task, therefore, can inadvertently be attributed entirely to the adult’s help, not to the child’s responsiveness and ability to retain and apply the other-regulated skills. While the child’s own self-regulatory development is at times coded (e.g. Pino-Pasternak, Whitebread & Tolmie, 2010), it is not typically coded as a *part* of scaffolding within existing scaffolding measures. The coding scheme proposed here allows for a measure of contingency founded on the mother’s level of intervention according to the child’s current challenge, while also acknowledging the effort and internalisation of the child as a crucial aspect of the *success* of the interaction.

### *Fading*

Scaffolding is a dynamic process; any learning takes place over time. Wertsch (1979) described how, as the child develops experience, knowledge and confidence, the mother gradually displays fewer other-regulating behaviours over the course of the task, following a transition of responsibility principle. The *fading* within Wood et al.’s 1976 description of scaffolding requires an observable shift in leadership of the task. Testing scaffolding quality would involve testing an overall fade from the mother across the interaction, which requires very fine-grained coding methods to pick up incremental changes. This causes problems for

coding schemes setting out to compare across families, where a single scaffolding ‘score’ is easiest for statistical testing. Some researchers have used detailed methods in their analysis, but then collapse them into a global maternal scaffolding or contingency score (e.g., Carr & Pike, 2012; Pino-Pasternak et al., 2010; Wood, Wood, & Middleton, 1978). What remains is the mother’s *average* fading throughout, while potentially insightful information about changes in the dynamic and development over time is lost. Pino-Pasternak and colleagues (2010) provide qualitative exemplars of this in addition to their quantitative coding; we intend to build on this by using fine-grained coding to explore and challenge the validity of the sample-level scores.

The coding scheme proposed here borrows from micro-developmental methods. This process-oriented method provides data capturing “real-time... evolution of skills and abilities of development and learning” (Granott & Parziale, 2002, p. 1), and has the potential to plot the children’s self-regulation skills as they emerge, are practised and refined, and eventually become automatic behaviours, whilst also following the other-regulating strategies of the mother as the task progresses, and how she intervenes at episodes of particular challenge. The bidirectional nature of dyadic interactions is particularly suited to mapping the dynamic of scaffolding (van Geert & Steenbeek, 2005), and could provide rich and detailed information on the scaffolded learning process (e.g. Van de Pol & Elbers, 2013) that are obscured when collapsed into global ‘scaffolding’ scores.

## Method

### Sample

The longitudinal dataset from the Sisters and Brothers Study (SIBS: Pike, Coldwell & Dunn, 2006) was re-analysed for this study. Mothers and children were recruited through mainstream schools in south England. The ninety children included in this study all had at

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least one older sibling. Twelve were discounted from coding, detailed below. Of the remaining children, 36 (46%) were girls; mean age 9 years 10 months ( $SD = 11.14$ , range = 8y - 11y 11m). Thirty-five mothers (45%) had no education beyond secondary school, twenty (25%) had a college education or vocational training, and twenty-three (30%) had undergraduate or postgraduate qualifications.

### **Procedure**

The mother and child were visited in the family home. The child was asked to complete the block design puzzle task adapted from the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974). With both mother and child seated on the floor or at a table, the child was given nine wooden blocks and a booklet featuring ten four- and nine-block designs, increasing in complexity. We treated the first three trials in Wechsler's task as practice rounds, while the child learns the nature of the task. At Trial 5, the designs start requiring nine blocks. The child was instructed by the researcher to make a copy of the design using the blocks, and once they had finished a design they could move onto the next. The child was asked to work through the booklet in his or her own time, and told that their mother was there to help them if they needed. Mothers were given basic instructions ("Each square is one block. Some of the designs use only four blocks but the ones towards the end use all nine blocks."). This activity was videotaped for later coding. In cases where the mother stated her own inability to do the task ("I don't think I can do this either"), the mother-child dyad was excluded from analysis entirely, because the mother was not meeting the assumption in scaffolding that the 'knowledgeable other' can complete the task themselves.

### **Behaviour Coding**

Since Wertsch's pioneering observations, few coding schemes measuring transfer of regulation have been devised and validated. We used the self- and other-regulation coding



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scheme for dyads developed by Nader-Grosbois and colleagues (Nader-Grosbois & Lefèvre, 2011, 2012; Nader-Grosbois et al., 2008). The scheme has been used to compare overall child self-regulation between groups; either comparing typically developing children to children with intellectual disabilities, or computer-based tasks to physical ones (Nader-Grosbois & Lefèvre, 2011). It has also been used to assess group-level self-regulation over the course of a task (Nader-Grosbois et al., 2008). Equivalent parental other-regulation scores have also been devised, and correlated with the children's scores (Nader-Grosbois & Lefèvre, 2012).

Of the seven aspects of regulation from the original coding scheme, six were included to measure child self-regulation (CSR):

- Exploration of means and planning (e.g. "I might start at the top corner");
- Joint attention (e.g. following points);
- Management (involvement and control of task);
- Attention;
- Motivation; and
- Evaluation (e.g. checking the booklet before moving onto the next trial).

We removed 'identification of objective' because the objective did not change after the practice rounds. These same six items were used to measure mother's other-regulatory behaviours, or MOR (e.g. for exploration of means, a mother suggests to the child that it may be useful to break down the design into parts). We extended the three-point scale of the original coding scheme (Nader-Grosbois & Lefèvre, 2012) to four points to increase sensitivity. In the CSR coding scheme, 1 was high display of that particular self-regulatory behaviour, and 4 was low display. In the mirroring MOR coding scheme, these same items were reverse-coded at the coding stage, such that 1 represented low other-regulation.

Behaviours were coded for either frequency (e.g., '3 instances or more'), proportion (e.g., 'throughout'), or extent (e.g., 'moderate'). For each completed trial, the mother was rated on

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the six MOR behaviours, and the child on the six CSR behaviours, yielding a total of 48 codes per individual, and 84 per dyad.

Fifteen percent of the videos were double-coded to check for inter-rater agreement. Percentage agreement was 94% to within one point on the scale (74% perfect agreement). Correlations between coders on each item were on average .92, ranging from .70 (child joint attention) to .99 (child motivation).

### Data Reduction

With such dense data collected on each family, we reduced the data in multiple ways. For the overall amount of CSR and MOR during *each trial*, we averaged across the specific regulatory behaviours at each trial. We calculated reliability for each behaviour type over the course of the task. For MOR, the mean alpha was .76, varying from  $\alpha = .83$  (joint attention) to  $\alpha = .64$  (evaluation). For CSR, the reliability was lower, mean  $\alpha = .61$ , varying from  $\alpha = .76$  (exploration of means and planning) to  $\alpha = .45$  (joint attention).

For CSR in a particular behaviour, we calculated the mean score of that behaviour across the seven trials, giving an overall score of the extent of their self-regulation in that behaviour *across the task*. We did the same for the MOR for each behaviour. To look at change in mother's and child's regulation over the course of the task, we computed overall CSR and MOR for each trial. Principal component analysis of regulatory behaviours at each trial, and subsequent reliability tests, yielded a robust single 'child self-regulation' factor, including all six behaviour types (planning, joint attention, management, motivation, attention and evaluation), whose reliability had a mean  $\alpha$  of .66 (varying from .54 at Trial 5 to

.72 for Trial 4)<sup>1</sup>. These scores during each individual trial were combined to get a mean score of CSR for that trial. The mothers' other-regulatory behaviours yielded a single factor of planning, joint attention, management, and evaluation (with a mean alpha of .79, varying from .75 at trial 9 and .87 at trial 4); attention and motivation did not load onto this factor. As with the child data, the mean of these four scores then produced MOR at each trial. Finally, to create an overall CSR score, we used the mean of the CSR scores across all seven trials; we computed overall MOR in the same way.

### Results

We shall first describe the global, collapsed scores typically used in scaffolding literature, and then look at sample-level insights into regulation behaviours and change over time. The second part turns to exploring what the fine-grained data can tell us about the tutored interaction and the other-regulation process that the sample-level scores may not.

#### **Part 1: General Findings across the Sample**

We used the averaged MOR and CSR scores across trials to show trends across the sample (Table 1). Overall, children showed high self-regulation, and mothers showed low other-regulation.

*[TABLE 1 ABOUT HERE]*

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<sup>1</sup> We retained all items for child self-regulation because there was no single item (or combination of items) which, when removed, consistently and substantially increased the alpha scores across designs. While these low scores suggest questionable reliability, it is in line with reliability commonly found within constructs of social science data (Field, 2013).

We also used the constructs of behaviour *types* to show trends across the sample (Table 1). Repeated-measures ANOVA, with Greenhouse-Geisser correction, confirmed that the types of self-regulation behaviour differed significantly,  $F(3.50) = 26.35, p < .001$ . Children scored highest in attention and joint attention, and were least self-regulated in their planning and in management of the task. It appeared, then, that children were stronger in responsive self-regulation behaviours, rather than the initiating, strategic ones. This also highlights the demands of this task in particular; attention regulation is a general, practised skill, whereas planning in these trials is more challenging.

[TABLE 2 ABOUT HERE]

Means of MOR behaviour types also varied significantly,  $F(3.37) = 67.39, p < .001$  (Greenhouse-Geisser corrected). Mothers other-regulated the child's attention very little, and other-regulated most in planning and joint attention. If the children generally scored highly in a behaviour type, the mothers generally had lower MOR scores of that behaviour type. This complementarity fits with the contingency principle and provides some validation of this coding method.

We also used our data to look at general trends in maternal other-regulation and child self-regulation over the course of the trials. Mean scores of each behaviour type were used to chart change from one trial to another (see Figures 1 and 2). A one-way repeated-measures ANOVA with Greenhouse-Geisser correction confirmed that overall CSR was significantly different between trials,  $F(4.67) = 24.32, p < .001$ . In Figure 1, Trials 1 and 4 have peaks of high self-regulation. The shift after Trial 4 corresponds to the task shifting from four-block to nine-block designs. The general downwards trajectory of self-regulation after Trial 4 is most pronounced in planning and in management of the task. Only in the last three trials do

attention and motivation start to drop. Evaluation is the only CSR behaviour that recovers during the final three trials.

*[FIGURE 1 ABOUT HERE]*

The mothers' mean other-regulation also changed significantly over the course of the task,  $F(5.20) = 43.10, p < .01$ . The average pattern of behaviour type changes over time (Figure 2) is a complementary mirroring of the children's. The other-regulation appear to be affected by the features of the trial; as with CSR, MOR is lowest during Trial 4. Mothers showed the most other-regulation in planning and joint attention; evaluation was comparatively low, and did not increase over the course of the task.

*[FIGURE 2 ABOUT HERE]*

**Correlations between child self-regulation and maternal other-regulation.** To look at the relationship between the mother and child scores, we correlated the overall CSR and MOR constructs, with bias-corrected bootstrapping to 1,000 cases. The correlation between CSR and MOR was very strong,  $r = -.75, p < .001$  (see Figure 3). Where the child showed high self-regulation during the task, mothers tended to show low other-regulation, and vice versa, fitting with the qualitative descriptions of original scaffolding observations (Wood et al., 1976). Correlations between equivalent mother and child scores on the individual behaviours and trial-by-trial were also calculated (see Table 2). The strong negative correlations show a pattern of opposite scoring, i.e. high CSR and low MOR, which fits with the *contingency* concept; within each trial if the child struggled the mother got more involved. Trial 3 showed the highest discrepancy in MOR and CSR, but the correlations declined over the following four trials, suggesting that the mother and child's scores were less complementary as the task got harder.

### **Part 2: Detailed Descriptive Analysis of Cases within the Sample**

Having produced sample-level, general findings, we used the rich data to look in finer detail at the particular aspects of scaffolding. We selected cases from the sample to examine variance between families, creating graphs showing the dynamic processes through the course of the task and charts of the specific regulation behaviours involved for each dyad. As the correlation between overall MOR and CSR was so strong, we selected families fitting this trend at either end of the spectrum, and families who did not (see Figure 3). Rather than contrast exemplar families at extremes (like Pino-Pasternak et al., 2010), we intended to contrast families who scored similarly at sample level in order to fully explore the variation of other-regulation styles.

*[FIGURE 3 ABOUT HERE]*

The scatterplot revealed that most families (e.g. Family A) demonstrated high child self-regulation and low maternal other-regulation. The detailed coding schemes showed this was typically where the child managed the whole task throughout, demonstrating high regulation in all behaviour types, and the mother was not involved because her contribution was not needed (see Figures 4a and 4b). This ceiling effect, then, of Family A is a basis from which to interpret the following families in other categories whose patterns deviate from this.

*[FIGURES 4A AND 4B ABOUT HERE]*

**Low child self-regulation, high maternal other-regulation.** Families B and C both received similar global scores of low CSR and high MOR. However, the graphs display very different behaviour between the two families.

For Family B, the child's self-regulation rates across the trials were highly variable, and by the final trials was very low; this suggests the child was not mastering the task. However, the levels of maternal support appear to complement the child's regulation during

difficult trials; the mother delivers a level of support at each trial that is *contingent* on the child's self-regulation levels (Fig 5a). Similarly, while the child struggled in planning and evaluation specifically (see Fig 5b), the MOR behaviours in these two areas were high.

[FIGURES 5A AND 5B ABOUT HERE]

Family C's dynamic over the course of the task is somewhat different (see Fig. 5a). The child had developed good CSR skills in the first half, and applied them effectively for the second, but from Trial 5 the mother kept delivering high-level MOR, which suggests that this mother was not calibrating the level of support in light of changes in the child's capabilities; there is no transfer of responsibility from mother to child. She provided more other-regulation in the behaviours that the child struggled with (Fig 5b). Thus, while the type of her other-regulation was appropriate, she delivered more than appeared necessary by the final few trials, unlike Family B.

**High child self-regulation, high maternal other-regulation.** For both Families D and E, the child's self-regulation stayed high for each trial. However, the MOR is markedly different. The mother of Family D delivered other-regulation relatively consistently, parallel to her child's (Fig. 6a), and she other-regulated the same behaviours the child did less well in (Fig. 6b); so while the other-regulation level was more than necessary, it was calibrated to the child's weaker skills. Family E's MOR levels varied over the trials (Fig. 6a), up to a score of 3.5, and did not follow the *fading* principle of generally decreasing in line with the child's capabilities; a slight drop in CSR after Trial 4 corresponded to a substantial jump in MOR. Furthermore, the mother scored highest in planning and management, neither of which the child scored particularly low in (Fig. 6b). This pattern of behaviour implies *over-regulating* behaviour from the mother, despite the global scores being similar to Family D's.

[FIGURES 6A AND 6B ABOUT HERE]

**Low child self-regulation, low maternal other-regulation** Families F and G also differed in the quality of scaffolding in terms of regulation behaviours and over time, when looking in detail. Family F demonstrated a complementary and contingent pattern of CSR and MOR (Fig 7a), whereby the mother's regulation is minimal while the child's is high, until the child's regulation drops and the mother moderately increases her other-regulation. In contrast, from Trial 5 onwards, the CSR of Family G decreased to a low overall score, showing the child does not master the task, but the MOR increased minimally over these final trials – and her response to a decline in CSR was markedly muted compared to other exemplar families. This might be interpreted as *under*-regulation (compared with Family E's over-regulation); she did not build up more structure around the child when needed, as *contingency* rules suggest.

In Figure 7b we observe some incongruity in regulation behaviours for Family F; while the child struggled most in planning, motivation and evaluation, the mother's other-regulated evaluation was low; so while her increasing support was timely, she increased support in some, but not all, of her child's weaker self-regulation behaviours. This is even more the case for Family G (for this family, Figure 7b only features the behaviours of the final three trials, to increase sensitivity for the detail in these trials). The slight raise in MOR was in planning and evaluation, which were the CSR behaviours that the child is having *least* difficulty with. Instead, attention and motivation, which the child scored lowest on, were not other-regulated at all in these final trials. While the mother's increase in other-regulation is timely, it is small compared to the child's decrease, and not supporting the self-regulation behaviours the child finds most challenging.

[FIGURES 7A AND 7B ABOUT HERE]



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The detail in this coding scheme reveals interesting contrasting interactions from families with seemingly similar scaffolding scores at a global level. By looking at the interaction both across the task and at particular regulatory behaviours of both mother and child, we observe diverse tutoring styles; some principles of scaffolding are adhered to while others not evidenced; we see over- and under-supporting; and some seemingly ‘non-optimal scaffolding’-scoring mothers in fact follow the principles of scaffolding but the low score is down to the child’s effort.

### DISCUSSION

This study applied a fine-grained coding scheme, following the principles of transition of regulation, to mother-child interactions, to offer a new micro-analytic insight to scaffolding and to reflect on the validity of existing scaffolding measures.

The findings from this coding scheme call into question the usefulness of global scaffolding scores often employed in the research area, when used in isolation rather than accompanied by qualitative exemplars to illustrate and to challenge the scores. In Part 1, the sample-level scores fitted with the shape of most scaffolding coding schemes: the mother's input is calibrated to the child's, in line with ideas of contingency, transfer of responsibility and fading. In Part 2, taking Nader-Grosbois and colleagues' coding scheme further and looking at individual dyads' variation in both measurable dimensions (regulation behaviours, and development during the task), we delved into a deeper level of detail, and we see many deviations from this pattern.

The time graphs and behaviour charts of individual families (Figures 1 and 2) showed that they all differ from the global scores from Part 1. Furthermore, two similar global scores do not necessarily equate to similar displays of CSR and MOR behaviours over the course of the task; in Part 2, even dyads who scored similarly in overall CSR and MOR showed substantial variations in the ways in which this goal was, or was not, achieved. While some children did not show mastery of the task by Trial 7, others were fully independent throughout. Mothers varied in the timeliness and complementarity of their support; some did not follow the *transfer of responsibility* and *fading* rules, while others delivered uncoordinated support that was not *contingent*. Some mothers provided more support to their child's less well-regulated behaviours, others in aspects that the child was managing well. This suggests that global scores of scaffolding may obscure highly informative detail, to the extent that even different maternal support receives similar overall scaffolding scores.

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Plotting the child's contribution as well as the mother's provides additional contextual insights. This is most significantly seen in the dyad with a *well-scaffolded* global score, whose fine-grained coding was in fact showing ceiling effects. While optimal scaffolding involves the mother being less involved where the child is mastering the task, the global scores inadvertently attribute optimal scaffolding to cases where the child is not struggling at all. Scaffolding quality should not be assessed if the child does not need help and is not learning. However, this study highlights that without the detail of the child's contribution to the task, cases such as these risk being categorised as optimal scaffolding. Additionally, it maps out at what point of this task the child may no longer be working within its Zone of Proximal Development, or has stopped engaging. In these cases even optimal scaffolding would not be effective for the child's learning (Vygotsky, 1978). Some coding schemes would categorise the quality of scaffolding as sub-optimal if the child does not improve; the coding of the child's self-regulation in this scheme suggests that the scaffolding principles can still be followed in cases where the child does not master the task.

The detailed micro-level codes of a dyad at times contradicts their corresponding global scaffolding score from Part 1. In some cases 'non-optimal scaffolding'-scoring mothers in fact follow some of the principles of scaffolding (e.g. Family F). The low score is down to the child's internalising; it appears that high quality scaffolding does not always result in independent management, at least in a task that gets progressively challenging. In other cases, a seemingly well-scaffolded dyad will in fact have a dynamic that does not fit with the scaffolding principles (see Family C). From this, we can evidence that collapsed scaffolding scores not only obscure highly informative detail, but even begin failing to accurately reflect the nature of the interaction it describes.

As well as assessing the validity of collapsed global scaffolding scores, the results demonstrate other uses and benefits of this coding scheme.

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The sample-level trends produced in Part 1 would be valuable in task analysis for scaffolding studies. Our data can make general comments about features of Wechsler's block design task as a scaffolded task, which may be distinct to other tasks set for mothers and children. The style and qualities of tasks provided by researchers vary widely (see Nader-Grosbois, Normandeau, Ricard-Cossette, & Quintal, 2008), and each has specific cognitive requirements, demanding different regulation behaviour. It is important to understand the particular demands a given task places on dyads. Further, it has the potential to help identify and remove cases in a dataset that demonstrate ceiling effects or interactions outside of the child's ZPD, neither of which can be present for genuine scaffolding to occur.

The descriptive information about the mother and child, such as that shown in Part 2, allows for a highly detailed and qualitative assessment of a particular dyad's interaction, which may also be valuable for diagnosing where individual dyads struggle most in the scaffolding process. The deviation of families from the sample-level scores shows a potential capability for more qualitative insights for feedback, training and better understanding of dynamic process in scaffolded interactions.

### **Limitations**

The main limitation of this coding scheme is its time- and resource-intensiveness; as such, it is not appropriate in all scaffolding analysis, especially those with large data sets. While the incremental trial-by-trial nature of the Wechsler task lent itself to episodic analysis, the coding scheme was not capturing sequential behaviour between mother and child; there was within-trial variation in MOR and CSR that was not accounted for. It is notable, then, that this coding scheme picked up so much variation, which suggests that the coding scheme is sensitive to dyad-level differences.

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The transactional account of dyadic interactions (Sameroff & Chandler, 1975; Sameroff & Mackenzie, 2003; Sameroff, 2009, 2010) describes an interaction as a series of responses by both members, whereby every action by one is a reaction to the other's preceding action, and so the dyad should be seen as a whole entity. This coding scheme did not provide a dyad-level unit of measurement. However, with the child's self-regulating behaviour having equal importance to the mother's other-regulating in this coding scheme, it is a step towards a more dyad-level position than many existing scaffolding coding schemes.

### **Conclusion**

While this coding scheme is not a definitive way to observe and analyse data from large samples, and is by no means a replacement of those currently in use, it offers rich and complex micro-analytic views of the interaction, which are often obscured by existing measures. By examining the dyadic interaction in great detail, with a scheme designed to fit with the original principles of scaffolding, the results offer reflections on and evaluations of existing scaffolding measures, especially those which use global 'scaffolding' scores, collapse their detailed data, and do not measure the child's contribution to the learning experience. This microanalytic measure, capturing the different corresponding regulation behaviours of both mother and child throughout the task, is shown to be a valuable tool for insights into the scaffolding research area.

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Table 1

*Means, standard deviations and ranges of self- and other-regulation*

	Mean (SD)	Range
<b>Demographics</b>		
Mother's education level (T1)	3.42 (1.5)	1 – 6
Child's verbal mental age (T1)	109 (9.0)	86 – 129
Child's age (T2)	118.6 (10.8)	97 – 140
<b>Child self-regulation</b>		
Overall	3.68 (.25)	2.76 – 4.00
By behaviour type		
Planning	3.47 (.51)	1.86 – 4.00
Joint attention	3.82 (.21)	3.14 – 4.00
Behaviour regulation	3.54 (.45)	2.43 – 4.00
Attention	3.89 (.20)	3.14 – 4.00
Motivation	3.79 (.30)	2.86 – 4.00
Evaluation	3.58 (.43)	1.71 – 4.00
By trial		
Trial 1	3.88 (.22)	2.83 – 4.00
Trial 2	3.68 (.35)	2.67 – 4.00
Trial 3	3.73 (.41)	2.17 – 4.00
Trial 4	3.91 (.22)	2.83 – 4.00
Trial 5	3.65 (.41)	2.00 – 4.00
Trial 6	3.51 (.44)	1.67 – 4.00
Trial 7	3.42 (.54)	1.83 – 4.00
<b>Mother other-regulation</b>		
Overall *	1.70 (.48)	1.03 – 3.03
By behaviour type		

## SCAFFOLDING UNDER THE MICROSCOPE

Planning	1.96 (.58)	1.00 – 3.57
Joint attention	1.96 (.67)	1.00 – 3.86
Behaviour regulation	1.65 (.53)	1.00 – 3.00
Attention	1.06 (.16)	1.00 – 2.00
Motivation	1.47 (.46)	1.00 – 3.14
Evaluation	1.43 (.47)	1.00 – 3.57
By trial *		
Trial 1	1.38 (.59)	1.00 – 3.75
Trial 2	1.73 (.67)	1.00 – 3.75
Trial 3	1.65 (.75)	1.00 – 4.00
Trial 4	1.26 (.48)	1.00 – 3.00
Trial 5	1.84 (.69)	1.00 – 3.25
Trial 6	2.15 (.75)	1.00 – 4.00
Trial 7	2.22 (.69)	1.00 – 4.00

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\* This construct uses the four other-regulation behaviours of joint attention, planning, behaviour regulation and evaluation, as per the factor analysis.

Table 2

*Correlations between MOR and CSR at behaviour level and at trial level*

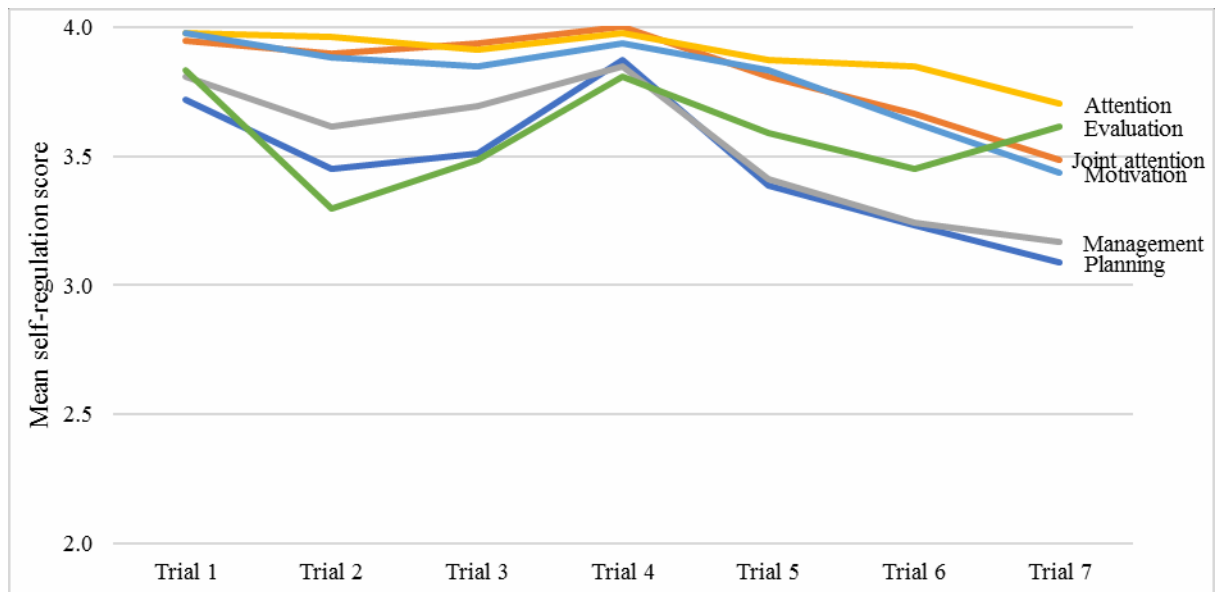
Behaviours		
	Planning	-.72
	Joint attention	-.32
	Management	-.47
	Attention	-.80
	Motivation	-.32
	Evaluation	-.86
Trials		
	Trial 1	-.70
	Trial 2	-.66
	Trial 3	-.80
	Trial 4	-.79
	Trial 5	-.63
	Trial 6	-.59
	Trial 7	-.58

*Note.* Bootstrapped listwise two-tailed correlations.  $p < .01$  in all cases.

## SCAFFOLDING UNDER THE MICROSCOPE

Figure 1

Mean child self-regulation over course of task



## SCAFFOLDING UNDER THE MICROSCOPE

Figure 2

Mean mother other-regulation over course of task

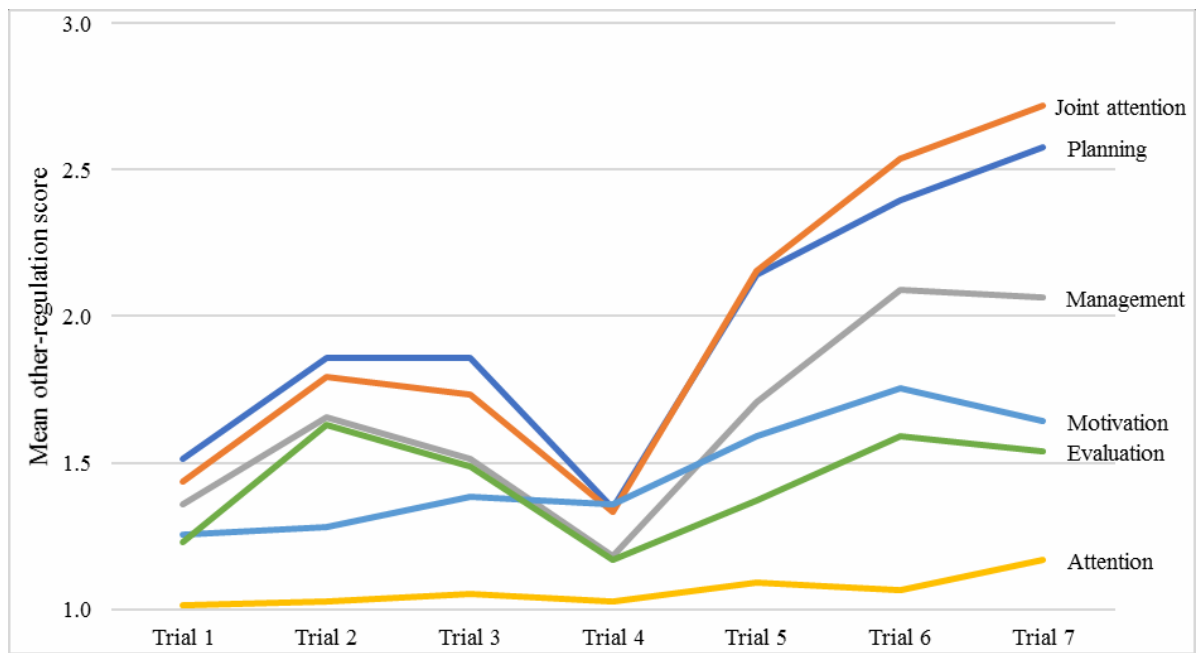
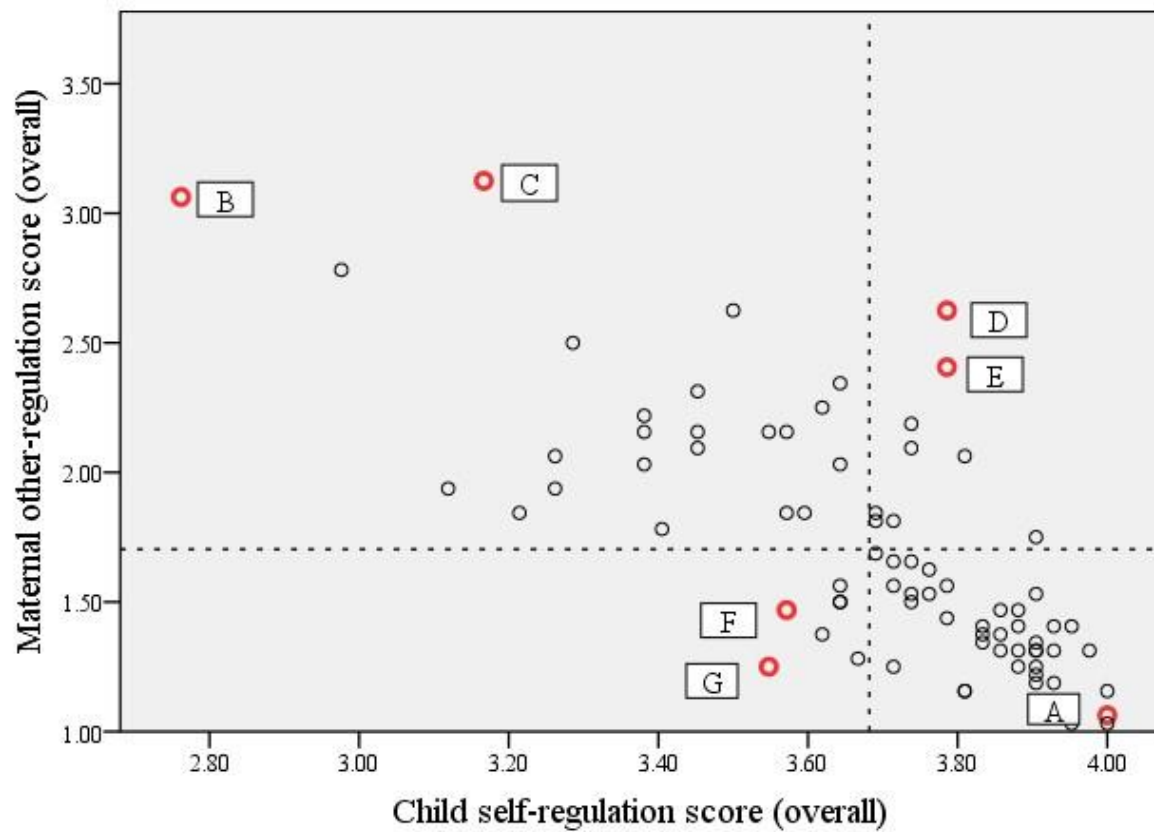


Figure 3

*Scatterplot of overall child self-regulation and maternal other-regulation scores*



Note: means of both scores displayed

## SCAFFOLDING UNDER THE MICROSCOPE

Figure 4a

Family A's self- and other-regulation over the course of the task

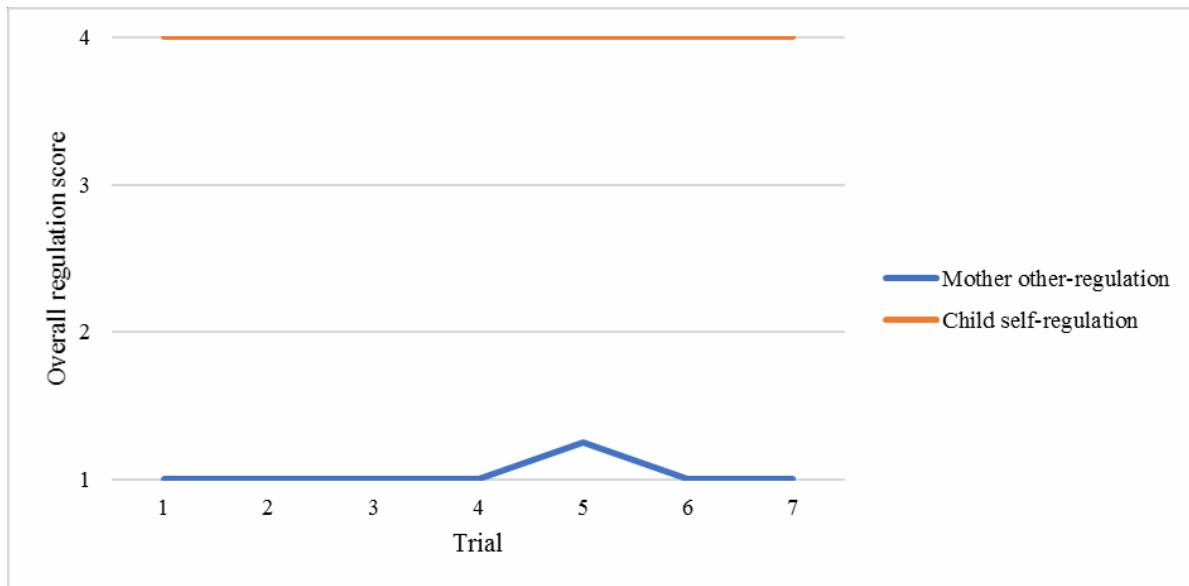
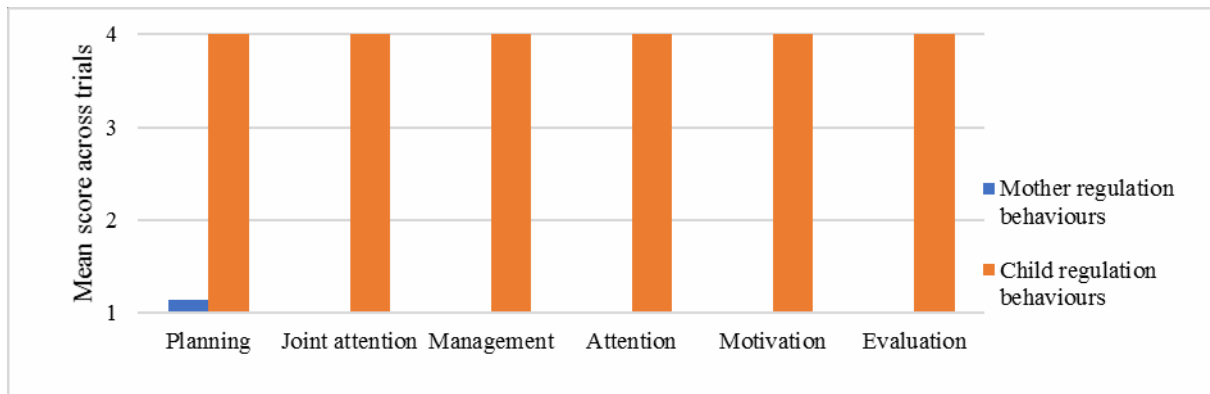




Figure 4b

Family A self-and other-regulation behaviours



## SCAFFOLDING UNDER THE MICROSCOPE

Figure 5a

Families B and C regulation over course of task

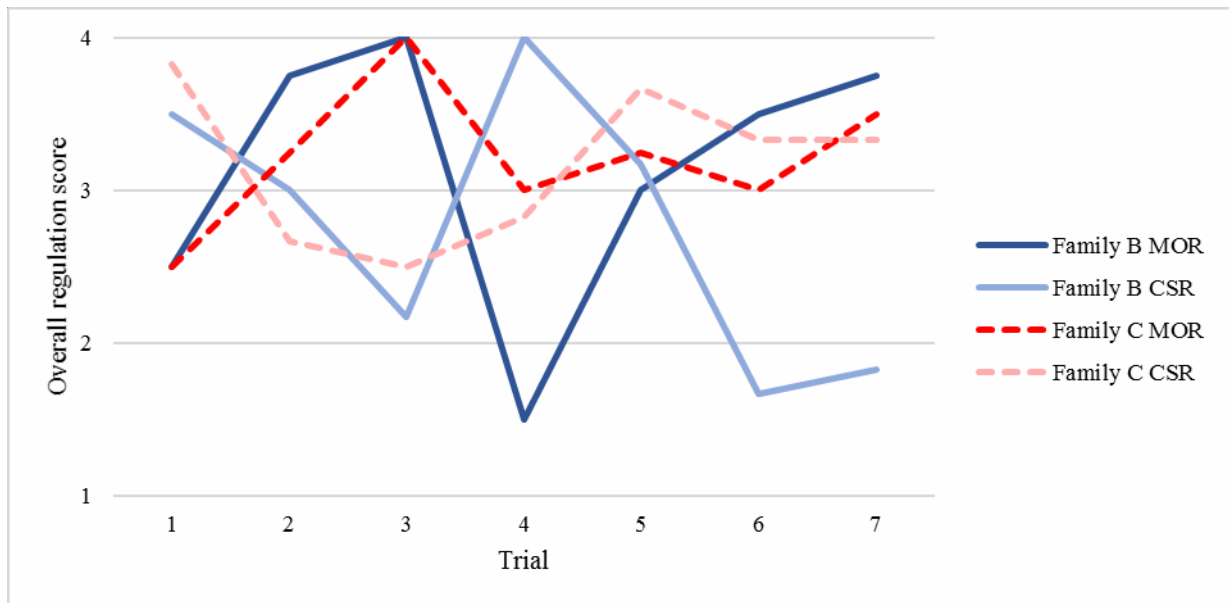
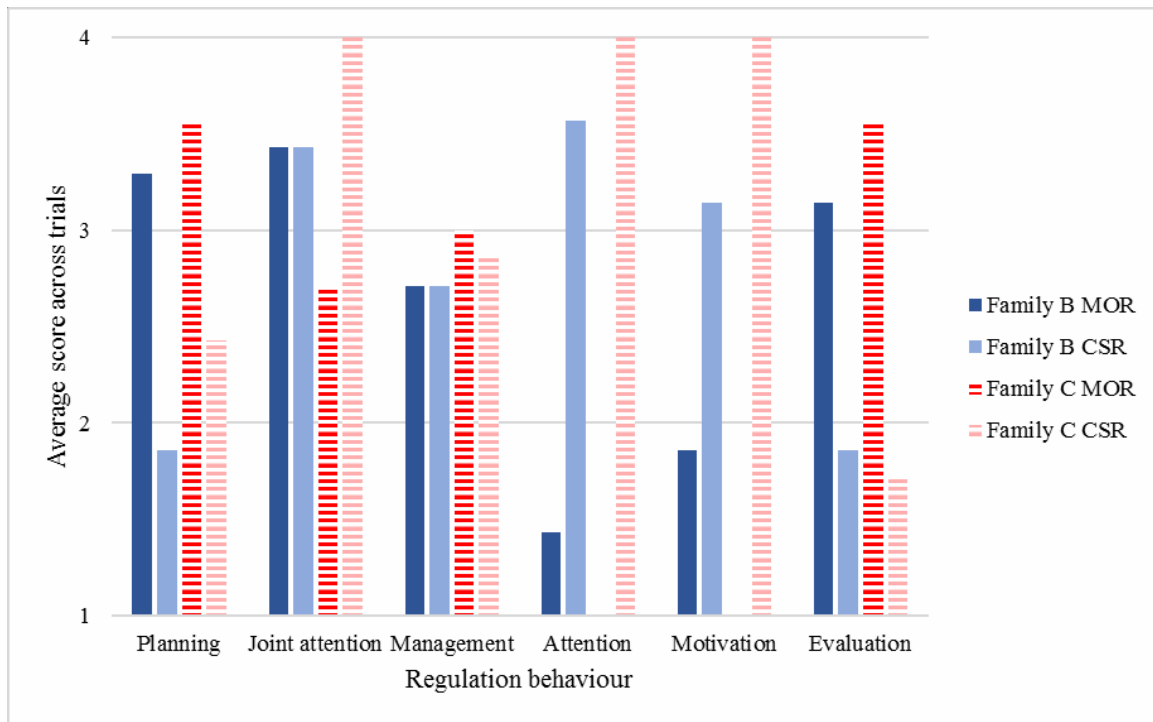


Figure 5b

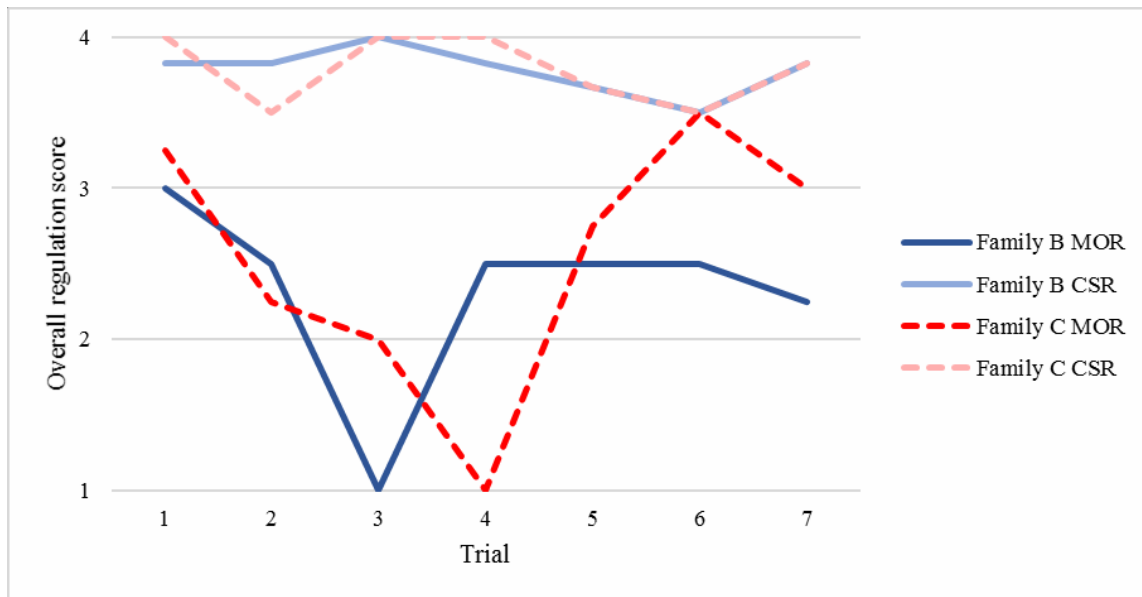
Families B and C regulation behaviours



## SCAFFOLDING UNDER THE MICROSCOPE

Figure 6a

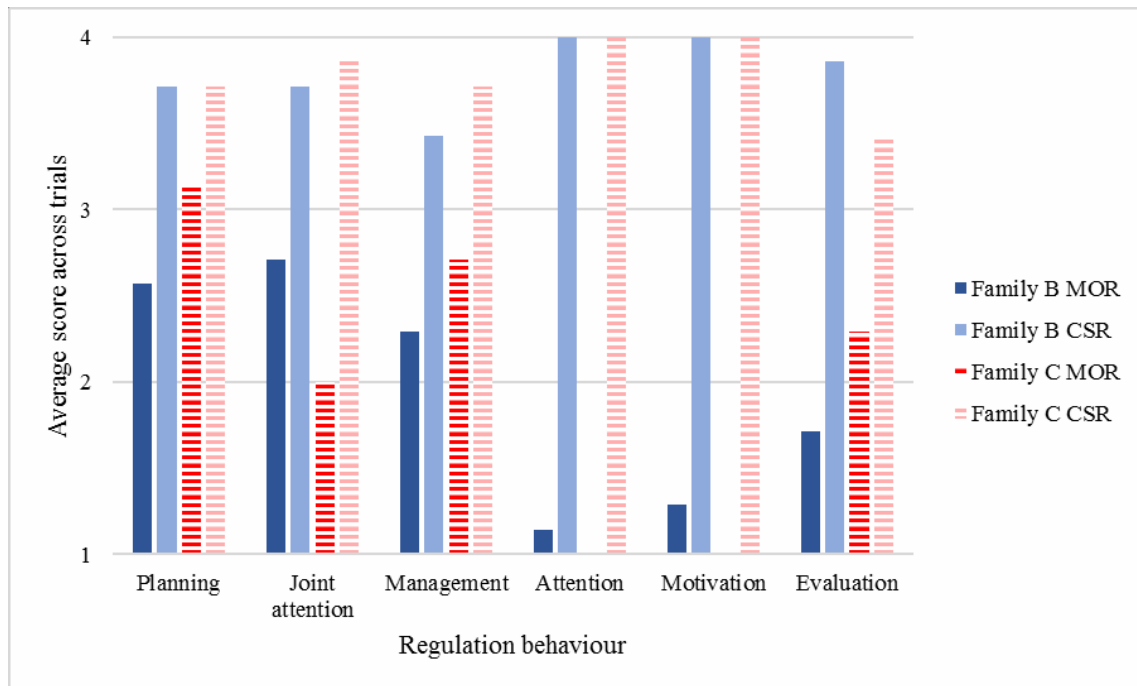
Families D and E regulation over course of task



## SCAFFOLDING UNDER THE MICROSCOPE

Family 6b

Families D and E regulation behaviours



## SCAFFOLDING UNDER THE MICROSCOPE

Figure 7a

Families F and G regulation over course of task

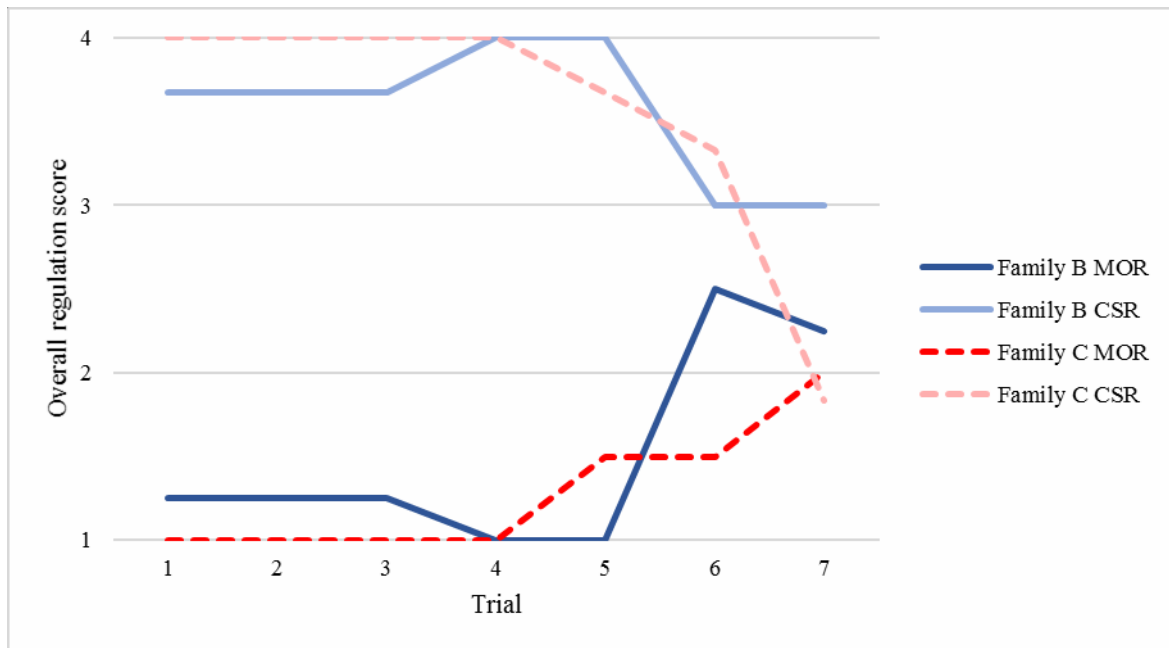
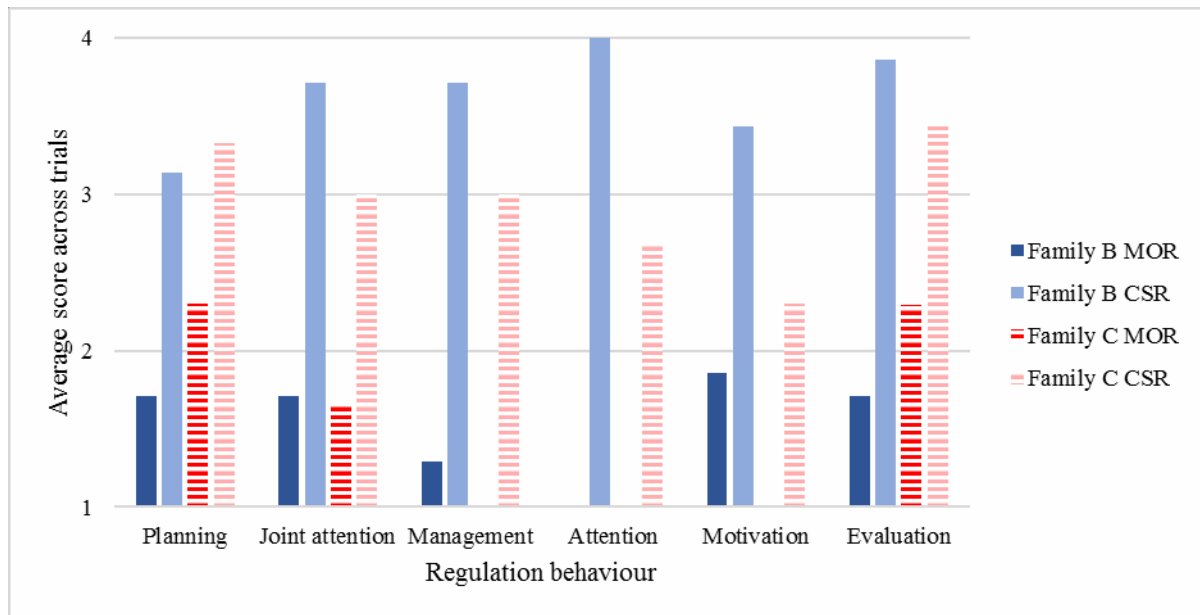


Figure 7b

Families F and G regulation behaviours



*Note: The data in this chart only features the behaviours of the final three trials of Family G, to increase sensitivity for the detail in these trials*